REMARKS

The Office Action dated September 13, 2002, has been received and carefully noted. The preceding amendments and the following remarks are submitted as a full and complete response thereto. Claims 1, 2 and 4-8 are amended. New claims 9-15 are added. No new matter is added. Claims 1-15 are pending in this application and are submitted for consideration.

Claim 6 was found to claim allowable subject matter but was objected to. Claim 6 is rewritten into independent form. Accordingly, the Applicants request that claim 6 be allowed.

An objection was made to the drawings under 37 C.F.R. § 1.83(a), on the grounds that D is not shown. Accordingly, a corrected Fig. 1 is submitted herewith that shows D. Accordingly, the Applicants request that the objection be withdrawn.

Please note that although D appears to be equal d1 + d2, as is explained on page 12 of the specification, D actually equals $(d1 + d2\sqrt{\varepsilon\nu})/\lambda_0$.

Claims 2, 4, and 8 were objected to under 37 C.F.R. § 1.75(c), as being improper depend form for failing to further limit a previous claim. Claims 1, 2, and 4-8 are amended herein. The Applicants submit that each dependent claim properly limits the previous claim to which it depends. Particularly, "n/2" is replaced with --2k/4-- in claims 2, 4, and 8, and therefore, D being within a more narrow range in claims 2, 4 and 8 than in claims 1 and 7. Furthermore, claim 8 has been amended to change "d" to --D--. Accordingly, the Applicants request that the objections be withdrawn.

Claims 1-8 were rejected under 35 U.S.C. § 112, second paragraph as being indefinite. In particular, in claims 1 and 7, there is no dimension, e.g., mm, cm, m, etc., given for the distance "D". The Applicants submit that distance D is fully

described as dependent upon the wavelength of a microwave, which in turn depends on the dielectric constant of a medium through which the microwave travels. The calculation of the distance D with the wavelength of the microwave being a distance unit is specifically described in the specification, and therefore, the Applicants submit that claims 1-8 are definite and particularly point out and distinctly claim the subject matter which is the invention, in accordance with 35 U.S.C. § 112. Accordingly, the Applicants request that the rejection be withdrawn.

Regarding claim 8, as already described above, claim 8 is amended to change "d" to --D--. Therefore, withdrawal of this rejection is earnestly requested.

Claims 1, 2, 7, and 8 were rejected under 35 U.S.C. § 102(b) as being anticipated by Sato et al. (U.S. Patent No. 5,861,601, hereinafter, "Sato"). Claims 3 and 4 were rejected under 35 U.S.C. § 103(a) in view of Sato. And, claim 5 was rejected under 35 U.S.C. § 103(a) over Sato in view of Otsubo et al. (U.S. Patent No. 4,985,109, hereinafter "Otsubo"). The Applicants respectfully traverse the rejections and submit that claims 1-5, 7, and 8 recite subject matter not shown or described by Sato.

Claim 1, upon which claims 2-5 depend, defines a plasma processing apparatus for processing an object to be processed using a plasma. The apparatus includes a processing chamber, a microwave radiating antenna, and a dielectric body. The processing chamber defines a processing cavity for containing an object to be processed and a process gas therein. The microwave radiating antenna has a microwave radiating surface for radiating a microwave in order to excite a plasma in the processing cavity. The dielectric body is provided so as to be opposed to the microwave radiating surface. A distance D between the microwave radiating surface and a surface of the dielectric body facing away from the microwave radiating

surface, which is represented with a wavelength of the microwave being a distance unit, is determined to be in a range satisfying an inequality, $0.7 \times n/4 \leqq D \leqq 1.3 \times n/4$ (n being a natural number). A standing wave of the microwave is formed between the microwave radiating surface and a plasma exciting surface, thereby exciting a plasma at the plasma exciting surface by being supplied with energy from the standing wave of the microwave, the plasma exciting surface substantially coinciding with the surface of the dielectric body facing away from the microwave radiating surface.

Claim 7, upon which claim 8 depends, defines a plasma processing method for processing an object to be processed using a plasma. The method includes steps of: putting an object to be processed and a process gas into a processing cavity defined in a processing chamber; radiating a microwave for exciting a plasma from a microwave radiating antenna having a microwave radiating surface to the processing cavity; providing a dielectric body so as to be opposed to the microwave radiating surface; and determining a distance D between the microwave radiating surface and a surface of the dielectric body facing away from the microwave radiating surface, which is represented with a wavelength of the microwave being a distance unit, to be in a range satisfying an inequality, $0.7 \times n/4 \leqq D \leqq 1.3 \times n/4$ (n being a natural number). A standing wave of the microwave is formed between the microwave radiating surface and a plasma exciting surface, thereby exciting a plasma at the plasma exciting surface by being supplied with energy from the standing wave of the microwave, the plasma exciting surface substantially coinciding with the surface of the dielectric body facing away from the microwave radiating surface.

According to claimed configuration, strong plasma can be generated just beneath a quartz plate, where microwaves are reflected. Therefore, by determining the distance between the antenna and the lower surface of the quartz plate based on the wavelength of the microwave, the standing wave of the microwave can be formed between the antenna and the lower surface of the quartz plate. This feature is not shown or suggested by any combination of the cited prior art.

Sato discloses a microwave plasma processing apparatus of an electron cyclotron resonance (ECR) system. In the ECR system, microwaves are not reflected around the lower surface of a quartz plate, which forms a microwave introduction window because only a weak plasma is produced around a lower surface of the quartz plate. Therefore, no standing wave of the microwave is formed between a slot antenna and the quartz plate. Consequently, Sato does not teach or suggest a anything that can form a standing wave of a microwave between a microwave radiating antenna and a lower surface of a dielectric body by determining the distance therebetween based on a wavelength of the microwave. Sato discloses the optimization of the distance between the quartz window and a slot antenna. However, this optimization is considered to be just for impedance matching, which is usually required in the ECR plasma system, but is not considered for forming the standing wave of microwave. Moreover, in the ECR plasma system, the determination of the distance between the slot antenna and a quartz plate based on the wavelength of the microwave is meaningless.

Otsubo discloses a plasma processing apparatus that generates plasma according to a cavity resonance system. However, Otsubo fails to disclose that a standing wave of a microwave is formed between the microwave radiating surface of an antenna and a lower surface of a quartz plate by determining the distance

therebetween based on the wavelength of the microwave, as defined by the claimed invention. Therefore, Otsubo cannot generate plasma that has a density as high as that of the present invention.

Thus, the Applicants submit that the combination of cited prior art fails to show or suggest each and every element of claims 1 and 7, upon which claims 2-5 and 8 depend. Accordingly, Applicants request that the rejection be withdrawn and claims 1-15 be allowed.

If for any reason the Examiner determines that the application is not now in condition for allowance, it is respectfully requested that the Examiner contact, by telephone, the Applicants' undersigned attorney at the indicated telephone number to arrange for an interview to expedite the disposition of this application.

In the event this paper is not timely filed, the Applicants respectfully petition for an appropriate extension of time. Any fees for such an extension together with any additional fees may be charged to Counsel's Deposit Account No. 01-2300.

Respectfully submitted,

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MARKED UP COPY OF THE AMENDED CLAIMS

1. (Amended) A plasma processing apparatus for processing an object to be processed using a plasma, comprising:

a processing chamber defining a processing cavity for containing an object to be processed and a process gas therein;

a microwave radiating antenna having a microwave radiating surface for radiating a microwave in order to excite a plasma in the processing cavity; and

a dielectric body provided so as to be opposed to the microwave radiating surface;

wherein a distance D between the microwave radiating surface and a surface of the dielectric body facing away from the microwave radiating surface, which is represented with a wavelength of the microwave being a distance unit, is determined to be in a range satisfying an inequality

$0.7\times n/4 \leqq D \leqq 1.3\times n/4$ (n being a natural number);

whereby a standing wave of the microwave is formed between the microwave radiating surface and a plasma exciting surface, thereby exciting a plasma at the plasma exciting surface by being supplied with energy from the standing wave of the microwave, the plasma exciting surface substantially coinciding with the surface of the dielectric body facing away from the microwave radiating surface.

2. (Amended) A plasma processing apparatus as claimed in claim 1, in which the distance D is determined to be in a range satisfying an inequality

$0.7\times \underline{2k/4}[n/2] \leqq D \leqq 1.3\times \underline{2k/4}$ $\underline{\text{(k being a natural number)}}$ [n/2].

4. (Amended) A plasma processing apparatus as claimed in claim 3, in which the thickness d is determined to be in a range satisfying an inequality

$0.7\times[n/2]\ 2k/4 \leqq d \leqq 1.3\times 2k/4$ (k being a natural number) [n/2].

5. (Amended) A plasma processing apparatus as claimed in claim 1, in which

the microwave radiating antenna is a radial line slot antenna having a number of slots formed and distributed in the microwave radiating surface thereof for radiating the microwave [,

a part of the number of slots is closed so as to uniformize the plasma generated in the processing cavity in a plane].

6. (Amended) A plasma processing apparatus [as claimed in claim 5, in which] for processing an object to be processed using a plasma, comprising:

a processing chamber defining a processing cavity for containing an object to be processed and a process gas therein;

a microwave radiating antenna having a microwave radiating surface for radiating a microwave in order to excite a plasma in the processing cavity; and

a dielectric body provided so as to be opposed to the microwave radiating surface;

wherein the microwave radiating antenna is a radial line slot antenna having a number of slots formed and distributed in the microwave radiating surface thereof for radiating the microwave, the number of the slots being [are] concentrically arranged in the microwave radiating surface[,]; and

wherein one per six or three slots in the peripheral direction of the slots arranged in the outermost peripheral part are closed so as to uniformize, in a plane, the plasma generated in the processing cavity.

7. (Amended) A plasma processing method for processing an object to be processed using a plasma, comprising the steps of:

putting an object to be processed and a process gas into a processing cavity defined in a processing chamber;

radiating a microwave for exciting a plasma from a microwave radiating antenna having a microwave radiating surface to the processing cavity;

providing a dielectric body so as to be opposed to the microwave radiating surface; and

determining a distance D between the microwave radiating surface and a surface of the dielectric body facing away from the microwave radiating surface, which is represented with a wavelength of the microwave being a distance unit, to be in a range satisfying an inequality

$0.7\times n/4 \leqq D \leqq 1.3\times n/4$ (n being a natural number),

whereby a standing wave of the microwave is formed between the microwave radiating surface and a plasma exciting surface, thereby exciting a plasma at the plasma exciting surface by being supplied with energy from the standing wave of the microwave, the plasma exciting surface substantially coinciding with the surface of the dielectric body facing away from the microwave radiating surface.

8. (Amended) A plasma processing method as claimed in claim 7, in which the step of determining the distance D includes a step of determining the distance D in a range satisfying an inequality

0.7×[n/2] 2k/4 ≦ [d] D≦1.3×2k/4 (k being a natural number) [n/2].